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nations. The following table exhibits the results:—

STATION.	Distance in miles.	Interval of transmission.	Velocity in miles per second.
Willet's Point, L.I.....	8.33	8.5	0.98
Pearsalls, "	16.78	6.6	2.54
Bay Shore, "	36.65	13.0	2.82
Patchogue, "	48.52	15.4	3.15
Goat Island, R.I.....	144.89	58.8	2.46
Harvard obs'y, Mass..	182.68	219.8	0.83
West Point, N.Y.....	42.34	{ 13.6 10.9 10.9	{ 3.11 3.88 3.88
Hamilton coll., N.Y....	174.37	{ 45.0 45.2	{ 3.88 3.86
Princeton, N. J.....	48+	51	0.94

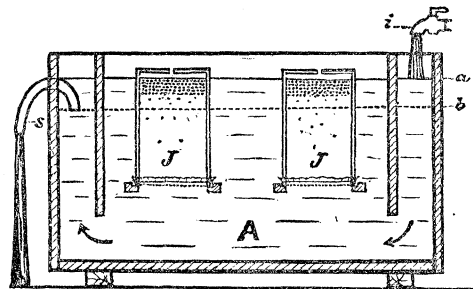
These wave velocities are any thing but accordant, and no satisfactory reason can be given for their variation; but they all agree in showing velocities that are higher than those deduced from observations on natural earthquakes; and from this General Abbott feels confirmed, in his deductions from the explosions of certain torpedoes and at Hallett's Point in 1876, that the more violent the initial shock, the higher is the velocity of transmission. At Flood Rock the charge was about six times as great as at Hallett's Point, and the velocity was from two to three times as great, over essentially the same route. Beyond this, the generalizations are not satisfactory. It is true that the velocities through Long Island, which is largely built of unconsolidated drift, are, on the whole, less than the accordant series up the Hudson valley, through rock; and the Goat Island and Harvard velocities, which must have been almost entirely through rock, seem to show a falling-off in the transmission as the wave weakened over increasing distance. But Hamilton is almost as far as Harvard, and yet its velocity is as great as at West Point; and Princeton must have felt a rock-wave at a moderate distance, and still its velocity had about the rate of that at Willet's Point and Harvard, which are very dissimilarly situated. It certainly cannot be thought that the initial velocity was slower than that at any later moment, except in so far as the nature of material traversed would affect it: therefore the apparent increase along Long Island should be looked for in the less percentage of distance traversed through the drift in reaching the further stations. But beyond this suggestion, hypothesis wanders too freely; and, unless the stations yet to be heard from solve the question, the explosion at Flood Rock has hardly taught us more than that earth-waves are very complicated, and that there is yet much to learn about them.

SUCCESS IN HATCHING THE EGGS OF THE COD.

FOR four seasons experiments have been carried on for the purpose of discovering a practical method of hatching out the eggs of the cod,—one of the most fertile and valuable of the food-fishes found off our coast. During the period mentioned no less than forty forms of apparatus have been devised and operated, with varying success, by different persons connected with the work of the U. S. fish commission. Up to the present time no device has fulfilled the required conditions, even approximately, with such success as the apparatus just devised by H. C. Chester, superintendent of the Wood's Holl station, of the commission.

This apparatus is essentially automatic, and needs so little attention that one man will by its aid readily care for a hundred million eggs. It consists of a trough seven feet six inches in length, two feet in width, and two feet four inches in depth. At about one foot from either end, vertical wooden partitions, extending to within four inches of the bottom of the trough, are secured. This leaves a space about five feet six inches in length between the partitions. In this space six or eight large glass jars are supported upon a frame, with their tops downward. Those used for the purpose at Wood's Holl are ordinary cylindrical, four-gallon specimen jars, with a half-inch hole drilled in the centre of the bottom. The stoppers of the jars are removed, and a single thickness of coarse cheese-cloth is secured over the mouth with strong twine. The jar is then inverted, and lowered into the trough, so that its bottom is about even with the top of the trough. Strips nailed across the top of the trough serve to keep the jars upright.

The accompanying figure, showing the device in



longitudinal vertical section, modified and designed on a somewhat smaller scale than the device now in use, and accommodating only four jars (two in a row), will enable the reader to get a clear conception of the way in which the apparatus is used. The trough *A* is filled with unfiltered sea-water

through the faucet *i*, the water rising to the level of the line *a*, before the capacious outlet siphon *s* begins to operate. This siphon, through which the water runs out of the trough faster than it comes in at *i*, soon brings the water down to the level of the line *b*, when the siphon takes in air and ceases to operate, after which the trough again slowly fills up with water to the level of the line *a*. This process is repeated automatically, and as long as the water is permitted to flow through the device. It requires ten minutes for the water to rise or fall from the one level to the other; and, since the jars have only a cloth tied over the mouth below, the water rises and falls to the same extent in them. This very slow and gentle rise and fall of the water in the jars and trough have been found sufficient to aerate the eggs, and give them all the movement they need.

The majority of the eggs in this contrivance float at the surface. Some, of course, remain suspended below the surface; but an exceedingly small percentage of the eggs ever sink and die, as in almost all of the other forms of apparatus hitherto used. The result is that the mortality is probably under five per cent, — a percentage of loss not greater than that experienced in the most successful treatment of shad ova.

The freshly fertilized ova, treated with an abundance of good milt, are introduced into the hatching-device through the hole in the centre of the bottom of each jar by means of a glass funnel. Beyond an occasional siphoning-off of the sediment on the bottom of the trough and the cloth covers of the jars, the eggs require no attention until hatched.

Heretofore great mortality has been caused by the use of metal in the construction of the hatching-vessels and strainers. Since the adoption of glass, wood, and cloth as the only materials used in the construction of the hatching-apparatus here described, combined with the very gentle movement to which the eggs are subjected, complete success has been attained. The eggs oscillate up and down through a space of only five inches from the level of *a* to that of *b*, and, withal, so gently that they suffer no hurtful shocks of any kind whatever. Captain Chester's device will doubtless be used with great advantage in the propagation of the Spanish mackerel. In twenty-four hours the latter would be ready to be set free from the apparatus; whereas it requires eleven or twelve days to hatch the eggs of the cod, with the temperature of the water ranging from 45° to 48° F.

Each of the jars *J* is seventeen inches high by nine inches in diameter, and will hold from one-half to one million of cod-eggs; so that an ap-

paratus of the style shown above, and occupying not much over a square yard of space, would accommodate from two to four millions of ova, in four jars.

These experiments show that violent movement of the eggs of the cod is of no advantage; that such movement is, on the contrary, injurious, if not mortal, when continuously maintained. The requisite conditions for successful hatching of this important food-fish having been settled, the great station of the fish commission at Wood's Holl affords unlimited opportunities for conducting the work for at least three months of the year, during which time from five hundred to one thousand millions of eggs might readily be hatched out by the aid of the Chester apparatus, and set free in the adjacent waters.

Since my arrival here, I have observed, that, some days after hatching, the larval integument over the head of the embryo cod is raised more and more from the top and sides of the brain. A spacious serous cavity is thus formed over the brain; so that, when the embryo is viewed from the front, it seems as if it bore a sac on the head almost as large as the yolk-bag formerly had been, attached to the top and sides of the head. On account of the fact that the young larvae of the cod seem to delight to remain near the surface, it has occurred to me that this vesicular sinus above the brain is of use in buoying the young embryos up after they have escaped from the egg. That this is actually true, I have every reason to believe from the circumstance that embryos a few days old never rest in the water in a horizontal position, but with the head uppermost, and the tail slanting backward and downward from it at an angle of 45°. When swimming, they move horizontally; but at once, upon coming to rest, the young fish assumes a slanting attitude, the tail dropping down into the inclined position, while the head is thrown up. The large sinus here described was first observed by me, in a less developed condition, on the head of the embryo Spanish mackerel in 1880. The space in this sac in that species I called the *supracephalic sinus*.

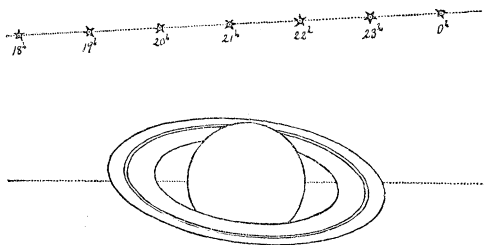
Since the foregoing was written, we have discovered that the specific gravity of the sea-water has a great deal to do with the healthy development of the eggs of the cod. By accident a broken valve admitted some fresh water to our salt-water tank, causing the specific gravity to fall from 1.0256 to 1.021 or 1.022. In this density the eggs immediately sank, causing us to lose over two millions. After this unfortunate experience, and also judging from the fact that ever since the break in the valve has been

mended no eggs have gone down, we have concluded that it is natural for cod-eggs to float, and that under no other conditions will normal development be accomplished. JOHN A. RYDER.

Wood's Holl, Dec. 21.

CLOSE APPROACH OF SATURN AND GEMINORUM.

ON the night of 1886 Jan. 9 (or morning of the 10th, civil time) there will occur a very close approach of the planet Saturn to the star μ Geminorum, whose magnitude is given as 3.22 in the Harvard photometry. The figure below gives the relative configurations of planet and star for successive hours of Greenwich mean time (astronomical) as seen in the ordinary inverting telescope.



To see it as it will appear to the naked eye, with an opera or field glass, or with a telescope having a terrestrial eyepiece, turn the diagram bottom upwards. At the time of nearest approach to the centre of the ball (a little after 21^h) the star will be about 26" from the centre, or 16" from the edge of the ball. For convenience the planet is figured as stationary, and the star as moving by it. Of course, the planet (as seen in the telescope) moves to the left, parallel to the line through the successive positions of the star. The dotted line through the planet's centre is parallel to the earth's equator, and makes an angle of 6° 35' with the major axis of the rings. The time of nearest approach is about five hours after the transit over the meridian of Washington, and is well visible over the whole of this country, though of course best for the Pacific slope, where it will not be so far down in the west. To convert the times given above into the standard civil times, add 7^h, 6^h, 5^h, and 4^h respectively, subtracting 24^h if necessary, which carries it into the civil day of Jan. 10.

Astronomically the event is of very little importance compared with what an actual occultation by the ring, or by the ring and ball, would be. A star as bright as this, and behind the rings, would offer a test we have never had yet of their possible transparency through interstices in the probable cloud of satellites. The action of the dusky ring

(not indicated above) would be especially interesting. A central occultation by the ball would give, by means of micrometric measures and the duration of the occultation, a sharp test of the refracting power of Saturn's atmosphere, and the possible semi-transparency of its upper cloud-surface. So near an approach of Saturn to a star as bright as the 3.22 magnitude is an exceedingly rare event. Assuming that the distribution of stars brighter than the 3.22 magnitude along Saturn's path is the same as the average, we find that only once in 612 years will Saturn approach so near one of them as on 1886 Jan. 9. Of course, actual occultations will be still more rare, and only likely to occur by the ring once in about 1,730 years, and by the ball only once in a little over 2,000 years. So near and yet so far from an actual occultation is the coming event.

H. M. PAUL.

THE CONVICT-LABOR PROBLEM.

THE attention of philanthropists and students of social science, which has for a long time past been turned toward this subject, has been increased of late by the attitude of the labor agitators. Perhaps not more than one out of every ten thousand laboring men gives the question of convict-labor competition a thought, but this odd one has during the last decade managed to stir up a great deal of discussion.

That convicts should be employed, and employed, if possible, in a manner profitable to the state, is a proposition that no sane man controverts. Now, there are various ways of employing convicts; and the agitators insist that one of these ways—the one, it so happens, which has in the past produced the largest revenue to the state—has an injurious effect upon the honest laborer by compelling him to submit to an unfair competition. Strange to say, this clamor has had some effect; though how sixty thousand convicts,—the whole number in the United States, according to the last census,—working as they do under peculiarly disadvantageous circumstances, and consisting of the lowest and most ignorant classes of the population, can effect any appreciable competition with the millions of honest and free workingmen, it is difficult to conceive. Those who join in this outcry are to a great extent communists, and leaders of labor organizations, whose sustenance depends upon the amount of agitation they can create, together with such political aspirants as aid them for purely selfish purposes.

The effect of all these elements combined has been visible in the statute-books of several states. Among these is New Jersey, whose legislature